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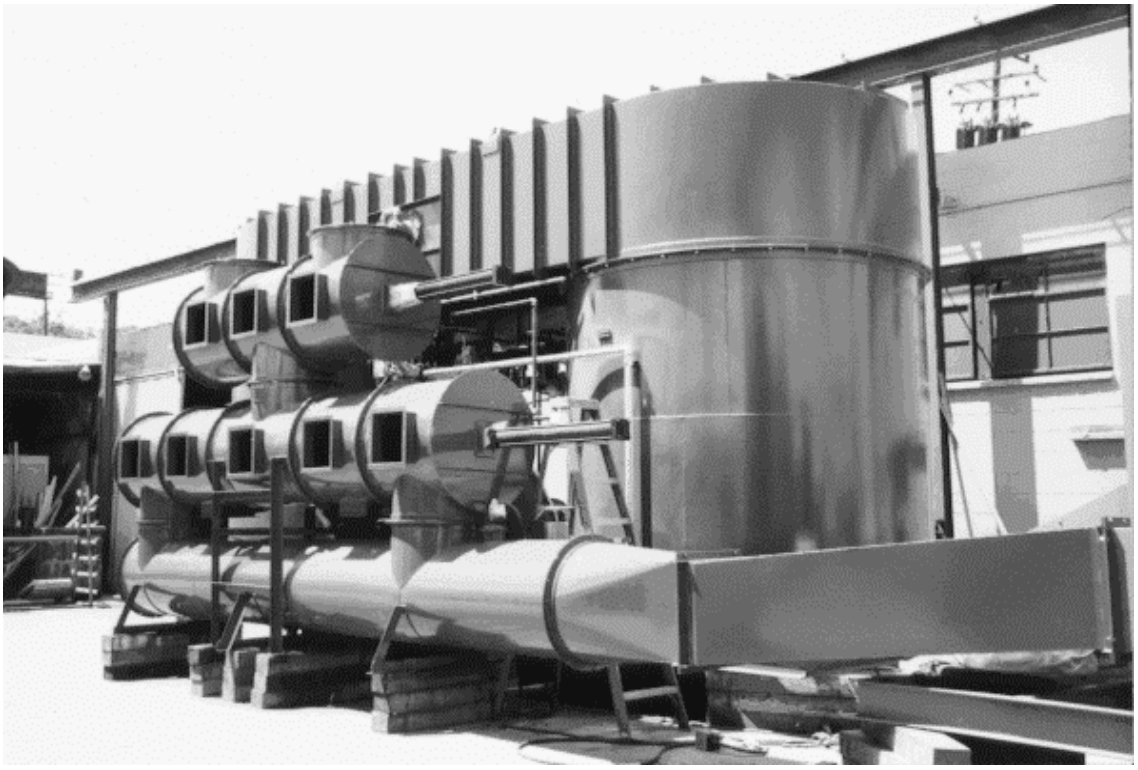
EPA Coalbed Methane Outreach Program Technical Options Series

CONVERSION OF COAL MINE VENTILATION AIR INTO ENERGY USING OXIDATION TECHNOLOGIES



Regenerative thermal oxidizers recover heat energy by oxidizing low-concentration fuels
(Photo courtesy of Ship & Shore, Inc.)

USING COAL MINE VENTILATION AIR, OXIDIZERS CAN...

- Operate efficiently using gas with high air volume/low methane concentrations typical of coal mine ventilation exhaust
- Recover up to 75% of the heat energy they produce
- Heat mine facilities and dry coal or slurry
- Produce thermal energy for use on-site at coal mines, or at nearby facilities such as boilers, steam turbines or electricity generators

Oxidation of coal mine ventilation air is a new application of a well-established technology

WHY CONSIDER USING MINE VENTILATION AIR IN OXIDIZERS?

For safety reasons, most coal mines worldwide dilute the methane liberated during coal mining operations to a concentration of less than 1%. At such low concentrations, it is difficult to use this methane gas mixture as a fuel. Oxidation technologies (which heat gases to their oxidation temperatures, converting the vapors to CO_2 and water) have long been used for the treatment of volatile organic compound (VOC) emissions, and will soon be tested with coal mine methane. Through high heat recovery, oxidizers provide a way to use ventilation air as heat energy while reducing methane emissions.

There are two primary types of oxidation technologies that can effectively oxidize methane: **thermal and catalytic**. Thermal oxidizers can utilize either a regenerative heat exchanger (direct contact heat exchange on inert material beds) or recuperative type (conventional, indirect heat exchangers) in their processes. Both thermal and catalytic oxidizers can be operated under unidirectional or reverse-flow conditions. Each type operates over a wide range of air flow rates and dilute methane concentrations. The systems produce excess thermal energy that mines could use for electricity generation, heating, cooling, and drying processes.

Regenerative oxidizers are self-sustaining at methane concentrations as low as 0.1%

The **regenerative thermal oxidizer** passes ventilation air through an inert bed of high heat capacity material (i.e. silica gravel or ceramic material) to a central combustion zone. Due to its stability, the methane molecule requires temperatures in excess of 1,000°C to automatically oxidize in air. Thermal energy resulting from this combustion heats up the media on the exhaust side of the bed. The flow is reversed allowing preheating of the incoming ventilation air. As a result, a relatively small amount of energy produces surplus heat, which can be evacuated through heat transfer piping.

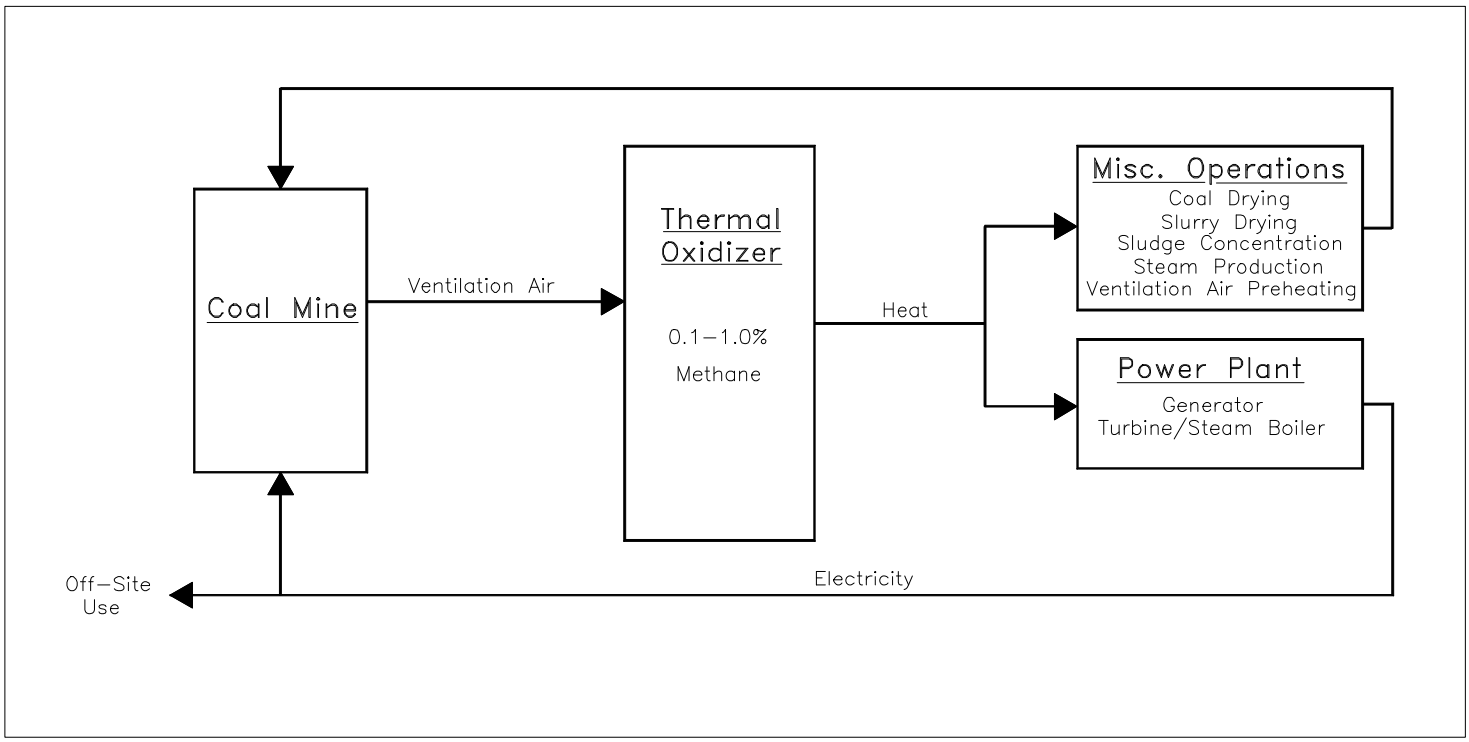
Operating at lower temperatures (500°C to 800°C), the **catalytic oxidizer** uses a burner in addition to a chamber bed to promote the oxidation of methane. Upon reaching a preheated temperature, the system reduces burner input to maintain the required catalyst inlet and outlet temperatures. Usually, the catalyst consists of a bed of metal or metal oxide substrate in the shape of pellets, which can be replaced and/or regenerated periodically. It should be noted that certain unidirectional catalytic oxidizers have difficulty oxidizing low concentrations of methane, and may be unsuitable for mine ventilation air.

The **reverse-flow catalytic oxidizer** combines the processes of heat exchange with the use of a catalyst. Storing heat in inert beds upstream and downstream of the catalyst section ensure a full methane conversion, in addition to promoting a high heat recovery rate. As a result, a coal mine can choose a more economical catalyst to lower operating costs. Neill & Gunter (Nova Scotia) Ltd. is currently co-operating with Natural Resources Canada and others in the development of this technology. An industrial demonstration is envisaged for the Spring of 1999.

High heat recovered (75%) is usable as thermal energy

While the above three methane oxidation technologies appear to be the most promising for methane use to date, other types of methane oxidizers may prove effective in the future.

USING COAL MINE VENTILATION AIR WITH THERMAL OXIDIZERS



TYPICAL PARAMETERS OF METHANE OXIDATION SYSTEMS

- Can operate at methane concentrations typical of coal mine ventilation air (0.1-1.0% volume)
- Primary heat recovery ranges from 50-75%
- Recovers heat at temperatures between 500-900^{o}C, depending on oxidizer type
- Can operate on high air flow rates ranging from 30,000-200,000 scf per minute
- Approximate installed costs range from $US 800,000 -1,200,000 (depending on the size of the facility)
- Can produce 25-35 MW of thermal energy

For More Information…

Coal mine operators and energy producers have long sought a means of using the low concentration methane contained in ventilation air. Thermal and catalytic oxidizers provide coal mines with several options for converting ventilation air into usable energy while reducing greenhouse gas emissions.

To obtain more information about using oxidizers to convert coal mine ventilation air into energy, contact:

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Or contact EPA's Coalbed Methane Outreach Program for information about this and other profitable uses for coal mine methane:

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